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CR-142325



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(E79-10294) SPATIAL THERMAL RADIOMETRY  
CONTRIBUTION TO THE MASSIF ARMORICAIN AND  
THE MASSIF CENTRAL (FRANCE) LITHO-STRUCTURAL  
STUDY Progress Report, Apr. - Aug. 1979  
(Bureau de Recherches Géologiques et)

N79-33526

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SPATIAL THERMAL RADIOMETRY CONTRIBUTION  
TO THE MASSIF ARMORICAIN AND THE MASSIF CENTRAL (FRANCE)  
LITHO-STRUCTURAL STUDY

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September 1979  
Type II for period April - August 1979

National Sponsoring Agency  
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Original photography may be purchased from:  
EROS Data Center

Sioux Falls, SD 57198

Report N° 1	
Spatial Thermal Infrared Radiometry Contribution to the Massif Armorican and the Massif Central (France), litho-structural study.	Report date September 1979
Jean-Yves SCANVIC	
B.R.G.M. Avenue de Concyr - B.P. 6009 45018 ORLEANS CEDEX FRANCE	Contract or Grant N° HCMM 18
Centre National des Etudes Spatiales 129, rue de l'Université 75007 PARIS. France	Type II Report April - August 1979

Analysis of works performed during the reporting period of this investigation using HCMM data is presented in this report.

Geology, mineral exploration and energy resources are concerned with the study located in the Massif Armorican and the Massif Central (France).

Only three good quality HCMM images have been obtained until now, cloud cover being very often important. Day and night thermal infrared data have not been acquired in the same day and so thermal inertia and temperature differences maps cannot be processed where interesting.

When possible visual interpretation has been done and reinforce previous spatial or aerial observations on some areas (Mont Dore, etc..) HCMM images seems to simplify interpretation by only outlining some of the Landsat lineaments and this aspect is to be investigated.

At last, even if the main work has been performed, on test sites, with others remote sensing techniques, and significant conclusions reached, the rare HCMM interpretable data bring out new geological features which have to be confirmed by further investigation.

## PREFACE

- Objectives and anticipated results of this investigation using HCMM data concern three disciplines :

- . GEOLOGY, MINERAL EXPLORATION, ENERGY RESOURCES.

Test sites are located over two parts of France, the Massif Central, in the central part of the country, and the Massif Armorican in the western region (Fig. 1)

Investigated Topic are : 1) regional thermal anomalies and volcanism  
2) carbonated rocks discrimination  
3) exothermic reaction  
4) change due to spatial resolution.

Analysis of works performed during the reporting period is presented in that order and for each one are distinguished:

- . HCMM interprétation
- . others remote sensing interpretation

For point 1 HCMM data brings out new observations which reinforce previous interpretations, on the Mont-Dore area, where B.R.G.M. is looking for a geothermal prospect.

Point 2 is not really investigated, because of the poor quality image over "Le Causse".

Point 3 has not been studied because thermal differences on the only one good quality image obtained are not caractéristic. Intensive works are performed with others technics one some area (Quintin granite)

Point 4 is extensively studied with other remote sensing techniques, over some test sites which allow to reach significant conclusions : the Riom circular anomaly (Limagne valley) and the Coat-an-Noz forest. But HCMM image are not good enough, until now, to be interpreted.

Point 5 at this early stage is promising because HCMM images, where usable, seems to simplify interpretation, outlining some of the Landsat lineaments, for a reason to be investigated, and new one - but strongly expressed, are now observed - This investigation needs more observations on good quality images.

The scope of work achieved during this period, which is mainly a visual interpretation, has been disturbed for two reasons :

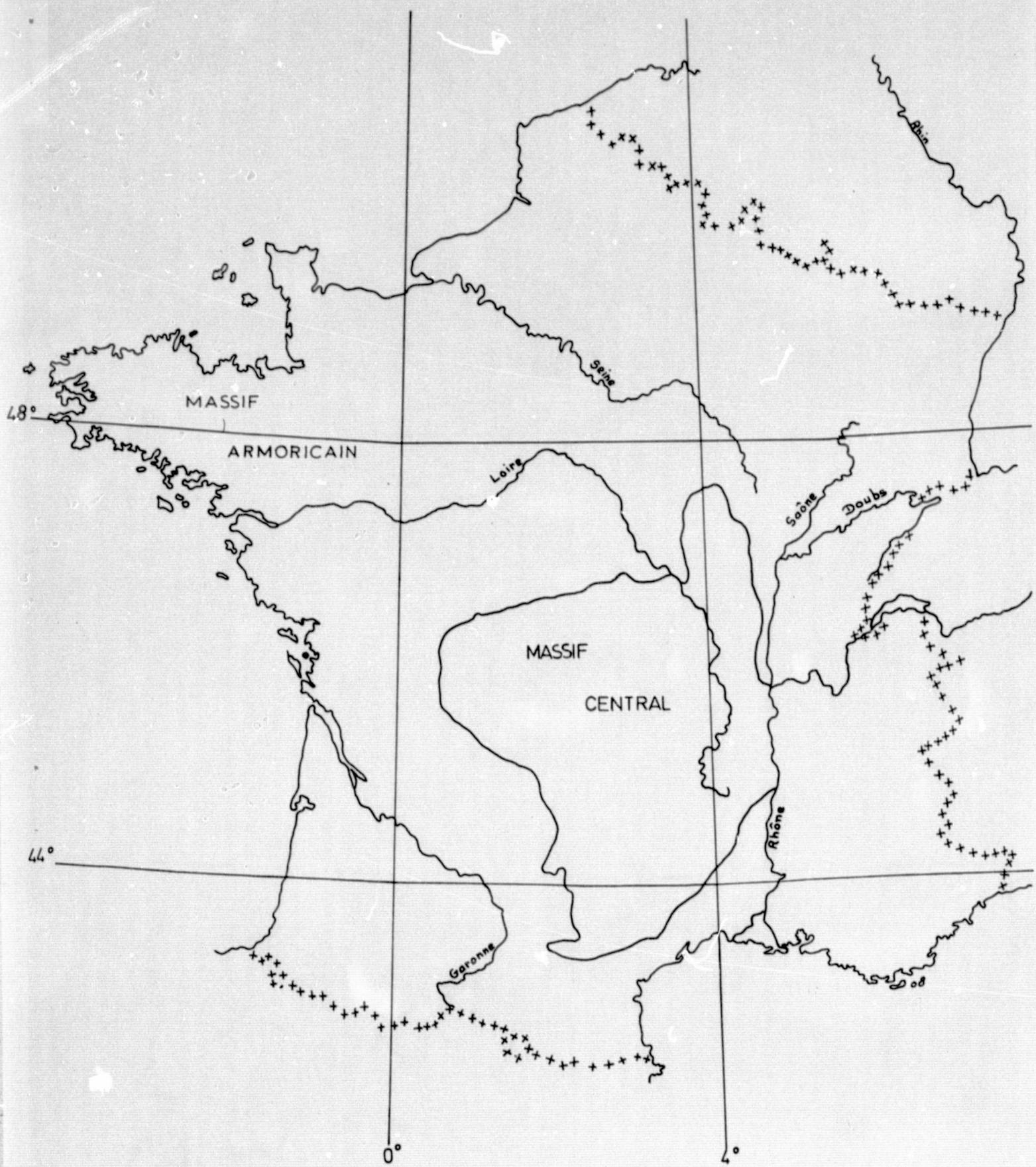
- . Poor quality images
- . Lack of same day and night infrared images.

Then it has been impossible to order, on some area of apparently good quality, thermal inertia or temperature difference maps.

Also, to improve interpretation, we are looking for the possibility to require Nasa for temperature map of that interpretable areas.

## TEST SITES LOCATION MAPS

## FRANCE



Any special conclusions can be reached at this stage. Scale and quality image are to be improved, by enlargement or processing for the first, by improvement of the weather for the second.

## TABLE OF CONTENTS

### INVESTIGATION RESULTS

1 .- INTRODUCTION	p. 1
1.1. BRIEF GEOLOGICAL COMMENTS ON SELECTED AREA	p. 1
1.2. COMMENTS ON RECEIVED DATA	p. 2
HCMM IMAGES RECEIVED	p. 3
2.- ANALYSIS OF THE WORK PERFORMED	p. 4
2.1. REGIONAL THERMAL ANOMALIES AND VOLCANISM	p. 4 p. 5
2.2. CARBONATED ROCKS DISCRIMINATION	p. 6
2.3. ROCKS DISCRIMINATION	p. 7
2.4. EXOTHERMIC REACTION	p. 7
2.4.1. Infrared sensing techniques	p. 7
2.4.2. Riom circular anomaly	p. 8
2.4.3. Aerial thermal infrared experiments	p. 8
2.5. EXOTHERMIC REACTIONS AND MINING GEOLOGY	p. 10
2.6. CHANGE DUE TO SPATIAL RESOLUTION	p. 10
2.7. PROGRAMM FOR NEXT REPORTING PERIOD	p. 11
3.- CONCLUSION	p. 11

## LIST OF ILLUSTRATIONS

Figure 1 Location map  
Figure 2 HCMM image - Massif Central  
Figure 2a HCMM image interpretation - Massif Central  
Figure 3 1/500 000 interpretation map - Mont Dore area (Landsat)  
Figure 3a 1/500 000 " " " " (HCMM)  
Figure 4 1/1 000 000 - HCMM interpretation - Massif Armorican  
Figure 4a The MASSIF ARMORICAIN HCMM image - Night infrared  
Figure 4b The " " Landsat lineaments.

## LIST OF TABLES

Table 1 HCMM images received ( July 75)

## INVESTIGATION RESULTS

### 1. INTRODUCTION

The investigation conducted during the past few months concerns the two areas selected for the project :

the "Massif Central" in central France

the "Massif Armorican" in western France.

Disciplines to be studied, following the instruction for the classification of proposals are :

- Geology
- Mineral exploration
- Energy resources.

Using heat capacity mapping mission images and all others available data purposes of this investigation are to study :

- The existence, or not, of regional thermal anomalies over various volcanic areas,
- The thermal ability to discriminate carbonated rocks,
- The thermal ability to discriminate various types of rocks,
- The existence, or not, of exothermic reaction over various selected sites,
- Difference due to change in spacial resolution, by comparing HCMM visible images with Landsat data.

#### 1.1. Brief geological comments on selected areas

- The "Massif Central" is a highlands zone of variscian orogeny and is composed by plutonic and metamorphic rocks, faulted at various epochs and partially covered by tertiary to subactual volcanism related to a "rift" system of fractures. Several tectonic basins are filled with mesozoic or tertiary sediments. It has been studied during the ERTS A investigation, B.R.G.M. being principal investigator ( S R 003 - 1). (Scanvic 1)

- The "Massif Armorican" is a hilly zone of hercynian-cadomian

The chosen objectives represent the main volcanic areas in the Massif Central, Chaîne des Puys, the youngest; the Mont Dore, a strato volcano the activity began 6 millions years ago and continue until 500 000 years ago, with a recent activation; the Cantal, probably the oldest (29 millions years to 3,7 millions) and also the Velay (13 to 6,5 millions years), the Aubrac and at least the Limagne valley (22 to 3 millions years).

Taken in July 78, on 17, night infra red HCMM image number A.A 0082 02080 3 is an acceptable one and a preliminary analysis has been achieved.

All the main volcanic areas are represented on this image but at this first stage visual interpretation does not indicate specially interesting correlations between temperatures differences and lava flows (fig 2 and 2 a) The Chaîne des Puys is warmer than the surrounding volcanic flow.(1) <sup>xx</sup> The Cantal shape is enhanced by a perfect correlation between lithology and morphology. Tonal temperature differences correspond with basalt flows and volcanic projections, the second looking warmer.(2)

The central part of the Mont Dore strato volcano correspond to subtil temperature differences and is enhanced by tectonic features we are talking on later.

Others volcanic zones cannot be distinguished but it exist quite a lot of small zones showing temperature differences which cannot be analysed at that scale. Enlargement have to be done for further analysis.(3)

Tectonic features visible on this image are interesting because they are not numerous but fairly represented by thermal differences. The main accident running north-south all across the Massif Central, the Sillon Houiller (4) is clearly visible and thermal image interpretation confirms its extent toward north and south, as stated with Landsat. At last the main fractures can be recognized and compared with Landsat interpretation. Some new features have to be investigated further.(5)

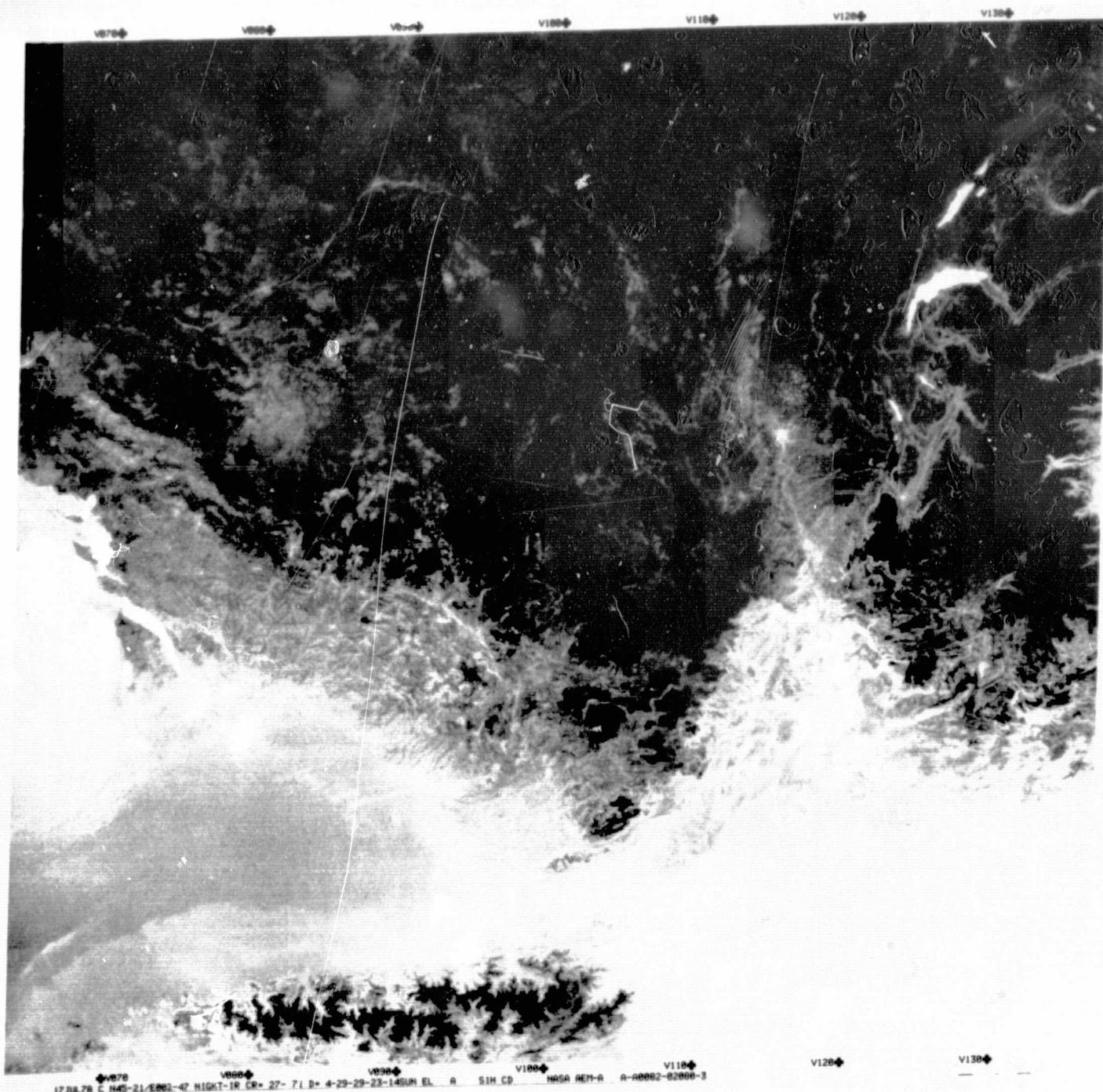
During the same period other remote sensing techniques have been used to determine the structural schema of the Mont Dore area, selected for a geothermal study. This investigation, still in progress, is under an European Community contract the aim is to delineate surface and burried structures which could correspond to geothermal prospects to be drilled. (Scanvic 4)

Aerial photographs, Landsat imagery, geophysical datas and field mapping have been used : Landsat and aerial photographs interpretation have outlined

<sup>xx</sup> points 1 to 5 : see figure 2 and 2a

Figure 2

NIGHT INFRARED HCMM IMAGE  
THE MASSIF CENTRAL ( FRANCE )

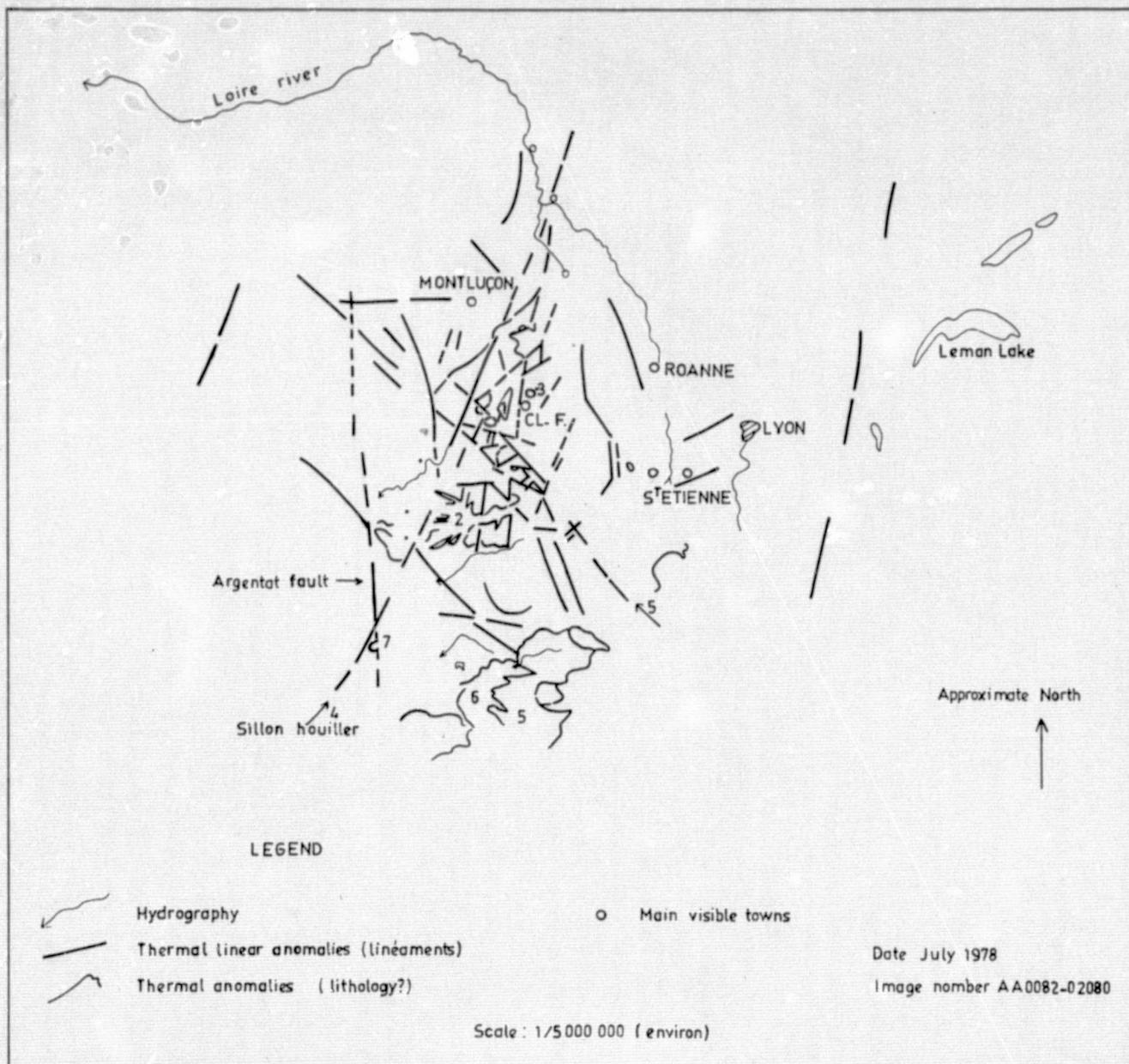


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## NIGHT INFRA RED IMAGE INTERPRETATION

The Massif Central ( France )



orogeny composed by plutonic and metamorphic rocks and partially covered by devono-silurian basins. The massif is constituted by three structural units :

- a northern unit running from the "Leon plateau" to "Cotentin".
- a southern unit, named the "Ligerian Cordillere" and giving to Armorique its typical aspect in paralell series.
- a central unit bounded with lineaments connected with two granitic areas.

The "Massif Armoricain" has been studied during the ERTS B investigation, B.R.G.M. being co-investigator in the FRALIT project (26 690) (Scanvic 2)

#### 1.2. Comments on received data

During the past few months 52 images have been acquired over the test sites, night and day infrared, day visible, but :

- Clouds conditions are generally very poor
- None of the infrared images have been acquired during the same day and so it is not possible to required temperatures differences and thermal inertia maps.

Only five images are usable, 3 over the "Massif Central" and 2 over the "Massif Armoricain". As mentionned above same day night and day infrared image do not exist over these two areas.

#### HCMM DATA PRODUCTS RECEIVED (AUGUST 1979)

2	July	78	Night IR	A A0067 02270 3	non usable
17	"	78	"	A A0082 02080 3	Massif central - Jura
2	"	78	"	A A0067 02280 3	Gironde - Pyrénées - clouds
11	"	78	"	A A0076 01550 3	clouds - Espagne - Pyrénées
6	"	78	"	A A0071 02020 3	non usable
6	"	78	"	A A0071 02040 3	non usable
11	"	78	"	A A0076 01570 3	France Sud-Est - clouds
30	June	78	"	A A0065 01510 3	Alpes Est
19	"	78	"	A A0054 01490 3	non usable
19	"	78	"	A A0054 01470 3	Alpes Est - good
8	"	78	Day visible	A A0043 12420 1	non usable

8 June	78	Day IR	A A0043 12430 2	non usable
30 "	78	Night IR	A A0065 01530 3	non usable except Corse and Sardaigne
1 "	78	Day visible	A A0036 13462 1	Espagne - Pyrénées - non usable
3 "	78	Night IR	A A0038 01490 3	Alpes Est - good
30 May	78	"	A A0034 02140 3	France Sud - good
30 May	78	"	A A0034 02144 3	France Sud - good
30 May	78	"	A A0034 02120 3	Nord France - Belgique - good
20 May	78	Day visible	A A0032 12360 1	non usable
		"	A A0032 12360 2	
11 May	78	Night IR	A A0150 02564 3	Bretagne - good
11 May	78	"	A A0015 02550 3	good - Pointe Bretagne
20 November	78	Day IR	A A0190 73090 2	Pyrénées méditerranéennes - non except
20 June	78	Night IR	A A0055 02070 3	sud Pyrénées - usable
7 December	78	Day visible	A A0225 12250 1	Est Pyrénées - clouds
7 "	78	"	A A0225 12260 1	Espagne - clouds
5 October	78	"	A A0162 12520 1	Alpes Est
27 "	78	Night IR	A A0184 13010 3	non usable
5 "	78	Day IR	A A0162 12520 2	?
5 July	78	Day IR	A A0079 12410 2	clouds
4 February	78	Day visible	A A0284 18530 1	Corse - Sud-est France - clouds
4 "	78	Day IR	A A0284 18530 2	?
4 "	78	"	A A0284 18510 2	non usable
30 October	78	Day visible	A A0187 12100 1	non usable
3 January	79	"	A A0252 18580 1	good clouds
3 "	79	Day IR	A A0252 18560 2	non usable
24 August	78	Day IR	A A0120 13080 2	good - France and Bretagne
24 "	78	Day visible	A A0120 13080 1	good
20 June	78	Night IR	A A055 02050 3	Massif central Est
22 July	78	"	A A087 02000 3	Massif central - Jura
3 June	78	"	A A038 01400 3	Est Leman - good
3 June	78	"	A A038 01490 3	Corse - Sardaigne
28 October	78	Day IR	A A0185 13100 2	Pyrénées - Gironde
28 "	78	Day visible	A A0185 13100 1	Pyrénées - Gironde
27 "	78	Night IR	A A0184 12590 3	Est Pyrénées
31 August	78	Day IR	A A0127 13300 2	Bretagne - Espagne - clouds
22 July	78	Night IR	A A0087 02020 3	Est Pyrénées
24 August	78	Day IR	A A0120 13060 2	Est Pyrénées
24 August	78	Day visible	A A0120 13060 1	Est Pyrénées
4 February	79	"	A A0284 18510 1	? Massif central
3 January	79	"	A A0252 18560 1	?
19 August	78	Night IR	A A0115 02180 3	"
15 November	78	"	A A0204 01360 3	Massif central - Gironde
				Corse - Alpes

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Consequently we have not been allowed to order special products, thermal inertia and temperature difference maps and visual interpretation is very limited.

From the end of June, the European space agency is receiving HCMM quick look products mailed by the Lannion station (France) in the framework of their contract with the Earthnet programme. The European space agency has concluded an agreement with NASA for the acquisition of HCMM data and it is foreseen that the agency will take over the NASA commitments towards the principal Investigators whose test sites are within the Lannion station coverage area.

In this framework the Lannion station has started distribution of Quick look products and B.R.G.M. is now regularly receiving HCMM products relating to its area of interest. Until now clouds cover condition of image received are very poor.

## 2. ANALYSIS OF THE WORK PERFORMED

Due to the poor quality of HCMM received data the work performed has been mainly made on aerial thermal infrared images, Landsat data and aerial photographs existing over the test sites. All the proposed topics have been surveyed.

### 2.1. Regional thermal anomalies and volcanism

The hypothesis to be investigated concerns the existence of thermal anomalies specific of the different magmatic areas. The idea was emitted by professor R. BROUSSE <sup>(3)</sup> who thinks several magmatic zones exist in the Massif Central and could have different temperatures. Spatial thermal infrared images could enhance this phenomenon because of the wide scale and the low spatial resolution : both of them could introduce a levelling of vegetation and slope which generally cancell heat flow.

Application concerns detection of potentially active volcanic zone and geothermal anomalies which are not detected by aerial thermal infrared images.

main basements fractures, unknown by previous surface geology (Fig. 3). Some of them are layed out by thermo-mineral springs, the regional tectonic situation was unknown. One of these lineaments corresponds with a magnetic regional and important crustal failure. Field mapping corroborates this new tectonic features, showing volcanism, tertiary or quaternary in age, is to be dependant of it. At last, all mesurements, magnetism, gravimetry and magneto-tellurism confirm the main lineaments outlined by remote sensing bound the central Caldera where geothermal prospects seem to be located.

Note to conclude that a circular structure observed on Landsat images (three different scenes) has been surveyed on the field and corresponds to an ancient and unmapped volcanic crater.

Having enlarged the HCMM image A.A 0082 -02080 3 we have then compared the interpretation; with the one obtained with Landsat, over the Mont Dore area.(Fig.3a) On that region tectonic data observed on HCMM image are new, or complementary, by refering to Landsat. HCMM gives a continuous pattern of fractures trending North 140°, bounding a zone looking like a hortz or a graben, extending toward south east, into the "Monts de la Margeride"<sup>(Granprat - 5)</sup>, a granitic zone where recent tectonic movments are known : in particular the Margeride hortz is very well caracterised by thermal differences.

These new observations are to be included in the CEE geothermal survey.

## 2.2. Carbonated rocks discrimination

Purpose of this investigation is to determine the ability of thermal images to discriminate carbonated rocks, a conclusion reached by L.C. ROWAN and K. WATSON. The test site area is located in the southern part of the Massif Central were Jurassic and cretaceous levels are well exposed in the "Les Causses" région. Over the test site we have acquiered aerial photographs at different scales, with different types of film ( colour, infrared colour, black and white), thermal infrared images (3-5 microns and 8-14 microns), radar, X and L bands, horizontal and cross polarization images. Landsat images have a good quality.

HCMM usable images are A.A 0082 - 02080 3, A.A 0034 2144 3 and A.A 0034 - 02140 3. Interpretation of thermal images shows temperature differences reflect some of the statigraphic differentiations known in that area : medium and upper jurassic level, composed by carbonated rocks, have a temperature colder

## CARTE DES LINEAMENTS LANDSAT

## Région du Mont Dore



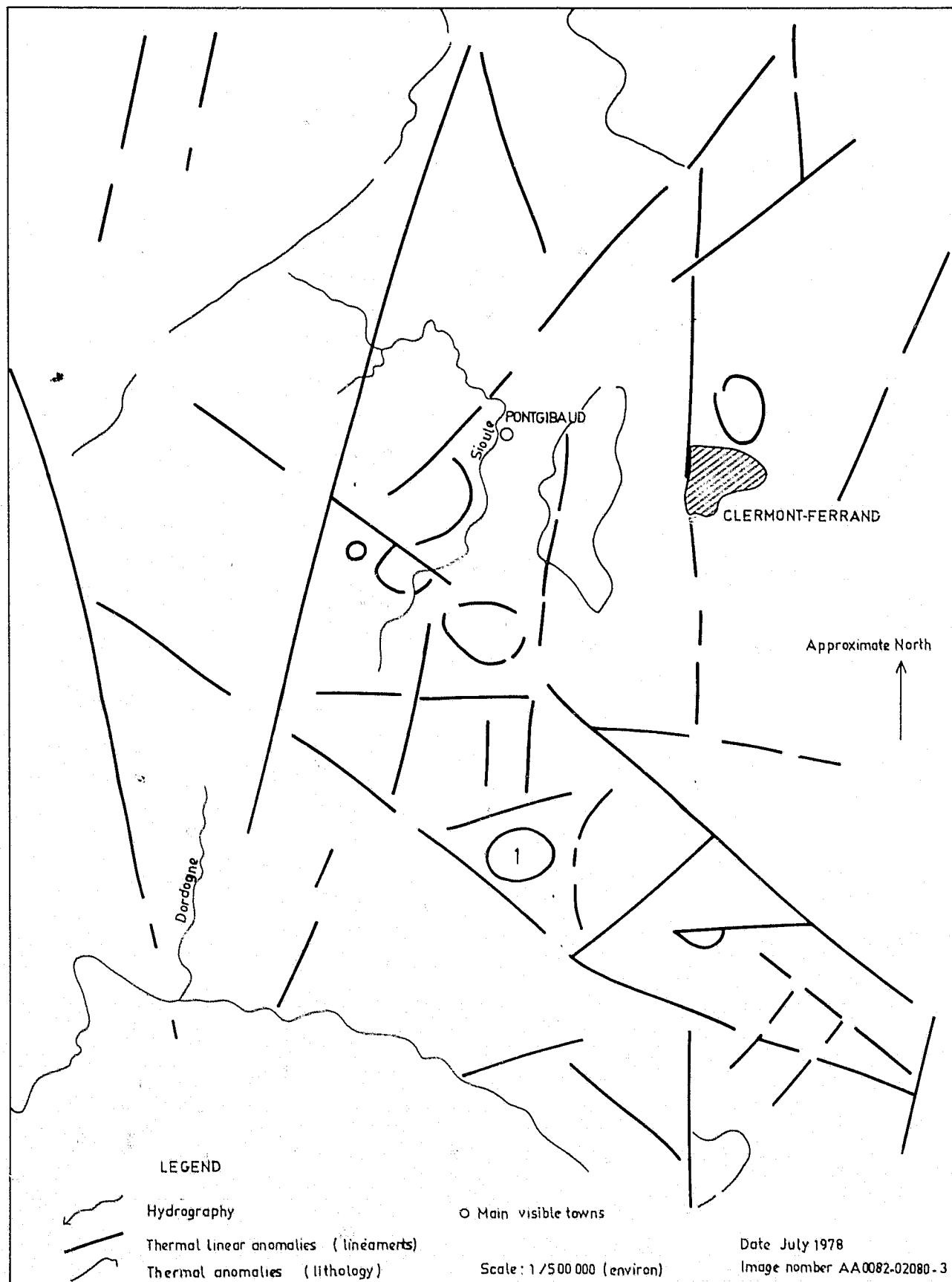
## LEGENDE

—	Lineaments très net	—	Discontinuité géophysique
—	Lineaments probable	L1..	Principaux lineaments
—	Lineaments hypothétique	V	Volcanisme de la chaîne des Puys
○	Structure circulaire	●	Source thermale

Echelle 1/500 000

# HCMM STRUCTURAL INTERPRETATION

## Mont Dore Region (France)



than the lower jurassic levels. But all the Jurassic sequence is composed by carbonated rocks with many lithological changes and differences on the HCMM images are very broad, even if exact, compared with field evidence. A such integration is probably due to the scale.(6)

A comparison, on an enlarged image, is scheduled with a Landsat image taken in september 76, which shows subtil differences in "the Causses" area as far as different spectral bands are concerned.

### 2.3. Rocks discrimination

Previous studies of Landsat images indicate their ability to discriminate different kinds of granites in the "Massif Armorican".

Interpretation of the main usable HCMM image number A.A 0015 - 02550 3 does not show a similar ability but confirms existence of the main lineaments outlined by Landsat.

During the reporting period intensive studies have been achieved on some of the granitic bodies, using aerial photographs, Landsat images, geophysic and field mapping and accurate tectonic and lithologic map could support further HCMM interpretation.

B.R.G.M. is also involved with C.N.E.S (Centre National des Etudes Spatiales) in a meteosat experiment over Africa and the first thermal inertia maps are promising, outlining the main known lithological differences.(Vieillefosse 6)

### 2.4. Exothermic reaction

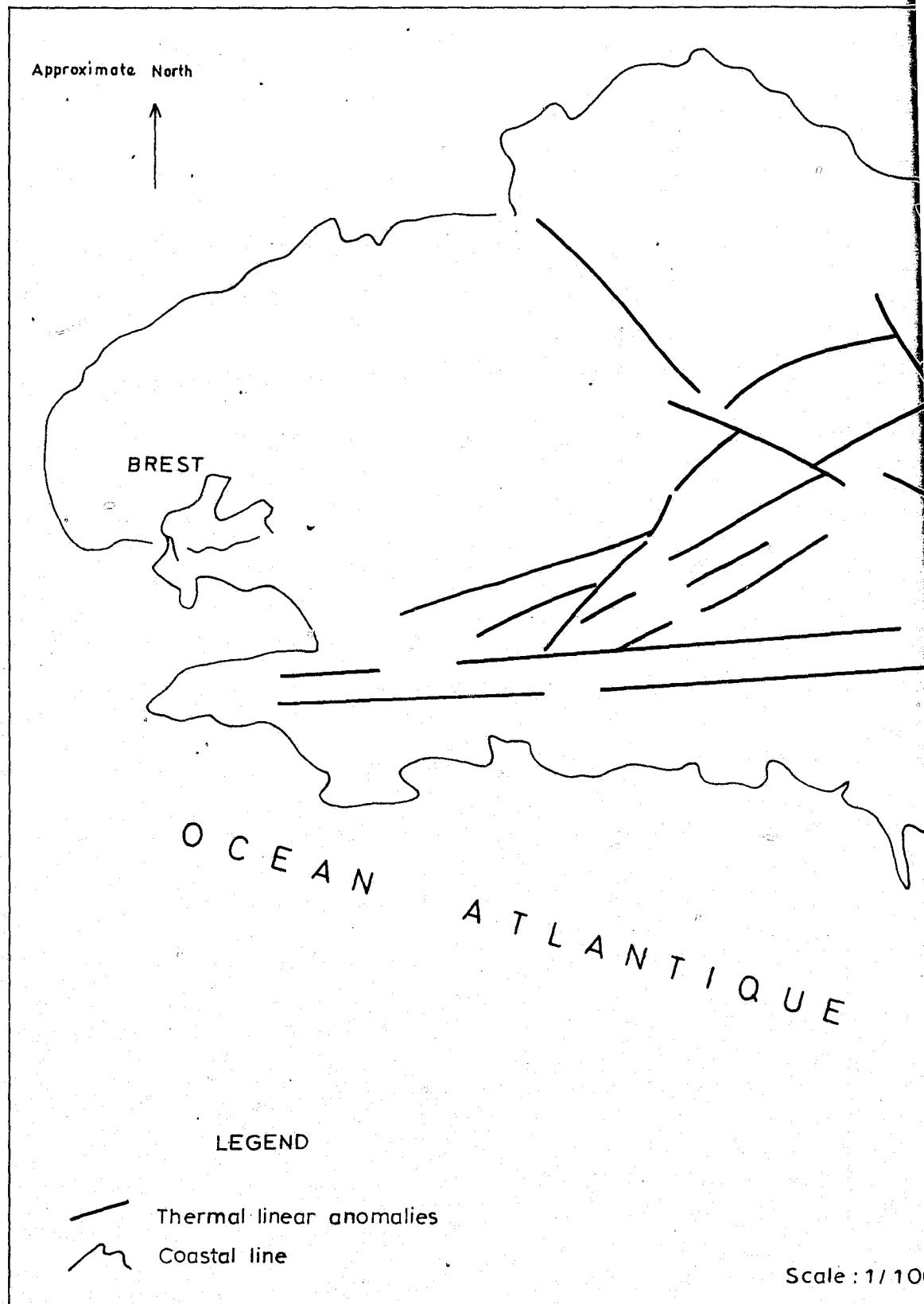
2.4.1. The idea is to determine whether or not the use of infrared sensing techniques could have an application to detect Sulphide area.

In the "Massif Central" chosen test sites cannot be observed on HCMM images because of cloudy conditions.

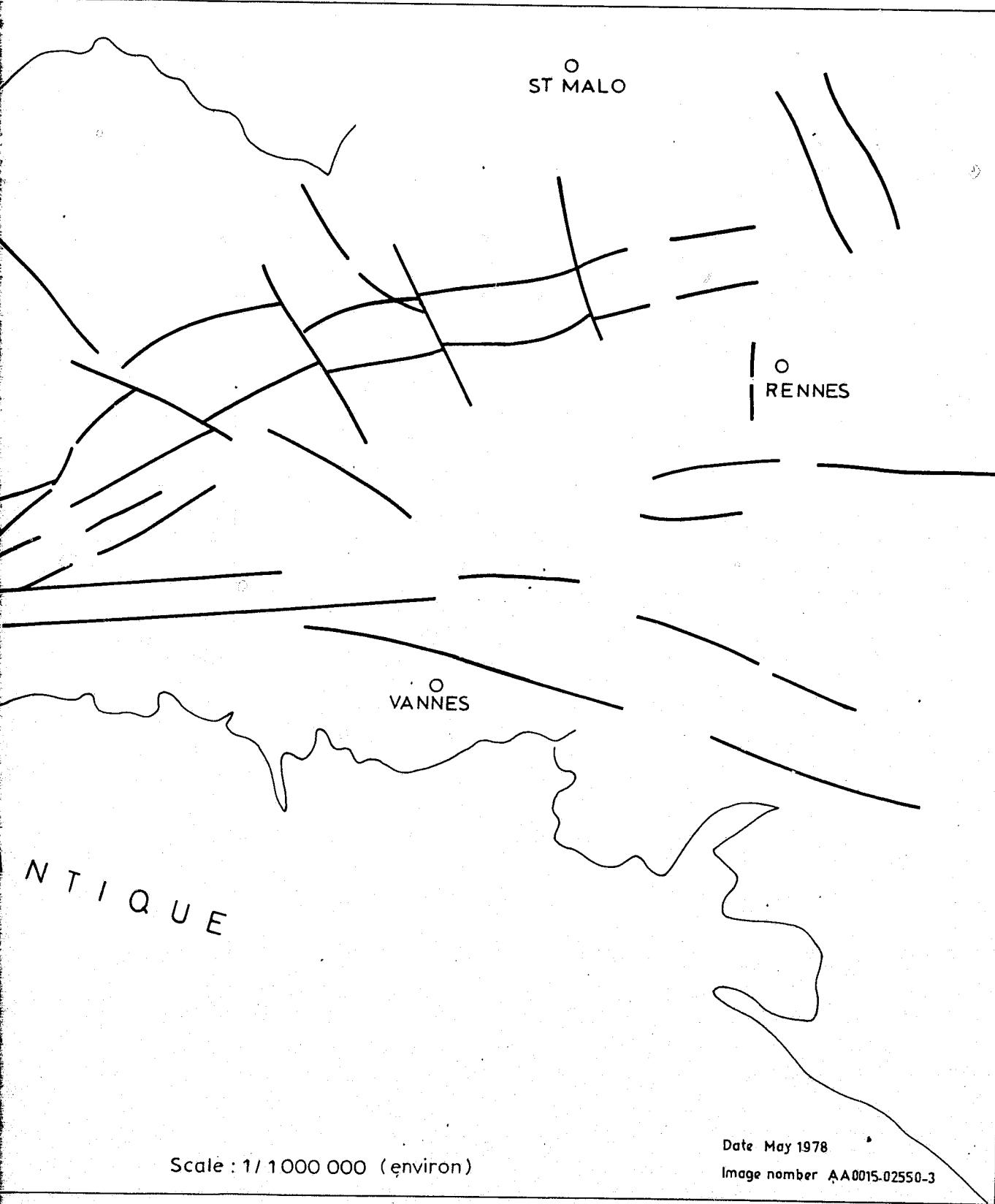
In the "Massif Armorican" further investigations with others HCMM images are necessary to conclude on the subject but the first preliminary interpretations do not outline significant differences. except for tectonic features.(fig.4)

Before and during the reporting period studies using others remote sensing techniques have been achieved in different places where thermic problems occur. They reinforce the idea of existing heat transfer from sub surface (2 or 3 meters) to soil surface, and the interest of moisture migration and vegetation as a revelator of buried structures or bodies. Results of these studies are significant enough to continue on the topic.

## Of the Massif Armorican (France)



morican (France)



#### 2.4.2. Riom circular anomaly

The circular anomaly is revealed by a Landsat image ( 1242 - 10082) in the Limagne valley (Massif Central, France); visible on band 7 it disappears on the others bands. On the ground there is no lithological difference, the surrounding area is flat. Comparison with an isobath map realized with geophysical and drilling data outlines a surimposition of the surface anomaly on the deepest part of a subsidence basin (2 000 m against 500 m in average). (Scanvic 7)

The question is : why this deep structure is revealed on the soil surface. Coincidence? W.H. ROBERT in his paper " the design and function of oil and gaz traps" presented to the association at Oklahoma City, April 1978, <sup>(8)</sup> opens the way to an explanation. W.H. ROBERT says in a sedimentary basin upward movements and discharge of waters from depth are very important and can lead to different moisture content on the surface, with circular or oval shape. And he adds : if this occurs it also occurs a change in temperature between central and lateral part, and a change in salinity.

And in fact on the ground the geotechnical map of Clermont-Ferrand (HUMBERT 1972) shows, on the southern part of the anomaly (the northern part is not mapped) a more important drainage and moisture. And J. REESLER, a BRGM hydrogeologist having studied the springs known in the vicinity, reveals it exists a more important content in chlorure inside the anomaly. (Oral communication)

At least, on a temperature map realized by the "Ecole Nationale des Mines de Paris" from NO AA3 data, a thermal difference exists on the circular anomaly. One other exists (3) on HCMM image, but not exactly at the same place.

All these observations are significant enough and promising to continue investigations on this test site if good quality HCMM image can be acquired.

#### 2.4.3. Aerial thermal infra red experiments

From several years B.R.G.M. has studied heat transfer from sub surface to soil surface by using aerial thermal infra red. Different test sites have been flight over.

First significant results have been obtained over the "Pays de Bray" anticline (Northwestern France) : a thermal anomaly appears on the 3-5 micron spectral band. Field mapping further demonstrates the anomaly corresponds to a limestone level partly outcropping but mainly underneath an overburden the thickness is estimated to one to two meters. (Scanvic 9)

In 1975 a survey is realized over "Les Vans" (Southern part of the

Massif Central, France) in a region where veins, mineralized or not, and a priori well mapped. J.M. BROSSE was responsible for the interpretation of different thermal infra red images which have been obtained at different time of the year. On one of these, taken at 4 ante matinem, a warm thermal anomalie, with a linear shape, is outlined along a quartz vein intruding schists. This quartz vein is cancelled by a two meter thick soil and homogeneous low vegetation and only a few boulders reveal its existence.

Ground temperature mesurements have shown a difference between schist and quartz during the day but a similarity at 4 ante matinem : then heat transfer is not a direct one and one can supposed the thermal change is due to variation of the soil-vegetation couple. (Brosse 10)

In 1975, an other experiment has been realized over the "Evaux-les-Bains" area, in the western Massif Central where an important veins network is known outcrops or not, covered with different type of vegetation. Images obtained have been analysed : locally results are significant for the method but in general they are disappointing.

In 1977 (May), using a SAT thermal infra red radiometer (four channels) a linear thermal anomaly has been registered from digitalized channels 3 and 4 (9,1 micron and 10,5 micron) over the Coat-an-Noz forest (Massif Armorican). Thermal anomaly concerns beech trees in the central part and extends on each side into different types of cultivation. It is 50 meters wide and 500 meters long. Temperature differences between warm and normal beech, from computer processing, is 2° centigrade and even 4° centigrade.

Ground check concerns geology, vegetation and thermohygrometry and has been conducted by Marie-José LEFEVRE, responsible for this BRGM/programm. (Lefevre 11) Drillings have revealed under the anomaly, and underneath 3 meters everburden, a 20 meters large granitic intrusive body, fairly fractured and saturated by water. This intrusion lay out the Devonian-Brioverian contact. Their is no geochemical anomaly.

The vegetation study has been realized and conclusions reached concern type of trees, and phenology. Their is no special thermophil vegetation, the forest is homogeneous but depends from lithology and water content. At last their is no phenologyc anomaly. Temperature has been registered during 8 continuous days and nights in the air and in the ground. These registrations show the only change in temperature is observed in the air, 1m50 above soil level (2° centigrade). This anomaly also exists on images taken one year later, in november 1978. A possible reason for this thermal change is the effect of the water content on roots.

- 10 -

This exemple is very interesting : it demonstrates the ability of thermal radiometer to detect subsurface geological formations, outlining the complexity of the interaction vegetation-soils-geology (and water content). This complexity, added to difficulties for acquiering data (meteorology, choice of flight time, etc..) reinforces the interest of spatial approach.

### 2.5. Exothermic reactions and mining geology.

In proposals for investigation we have mentionned B.R.G.M. interest for a remote sensing techniques able to detect and record heat production by pyrite oxydation. Some of the proposed test sites have been studied with other techniques to support further HCMM interpretation. They are :

- Chiseuil (Massif Central), were several oxidizing sulphides areas are known in the vicinity of the main are body. Aerial photographs and Landsat images have been interpreted and new field works are in progress.
- Bodennec(Massif armoricain-), a Pb, Cu, Zn deposit, where intensive field work are in progress. Landsat interpretation outlines the main volcano sedimentary Cu, Pb, Zn deposits known in the Massif armoricain lay out North south lineaments which correspond, at last where occurences are known and studied in detail, to permanent structural axis(Cambrian to upper Devonian) along which are located several volcanic events of various age. This paleo-crystal failure is also supported, in the sea, by magnetism: mesurements.

About 9 occurences have been studied : all of them are located along these North south lineaments but also at a crossing point with North 70° lineaments the most important of them being observed on HCMM images. (Fig. 4 a and 4 b)

### 2.6. Change due to spatial resolution

This part of our investigation is to be conducted by comparing visible image (Landsat) to HCMM images over two areas :

- Villefranche de Rouergue, where we have studied photographs and spatial images at different scales.
- The whole Massif Central.

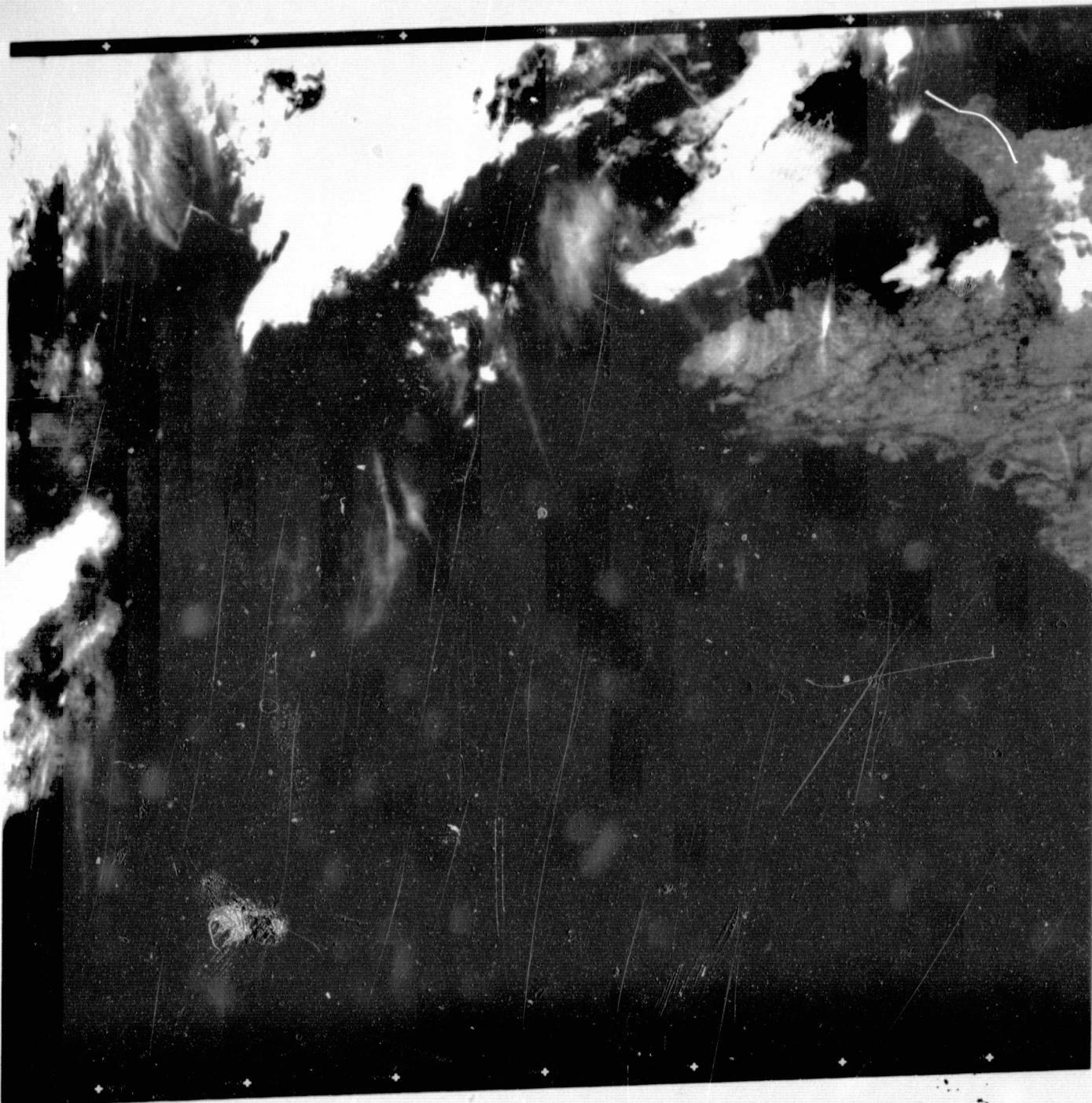
HCMM image quality doest not allow a complete interpretation of the two areas but :

• the circular structure discovered on Landsat into the Sansevensa granite (Villefranche de Rouergue) and studied by J.M. BROSSE<sup>(10)</sup>, is clearly visible on HCMM image. (point 7)

• as stated above (Le Mont Dore) the main fractures visible on Landsat are observed on HCMM. In general HCMM interpretation is less detailed but locally new features are revealed.(figure 2)

Figure 4 a

NIGHT INFRARED HCMM IMAGE  
THE MASSIF ARMORICAIN ( FRANCE )



Scale : 1/5 000 000 (environ)  
inverse print

ORIGINAL PAGE IS  
OF POOR QUALITY

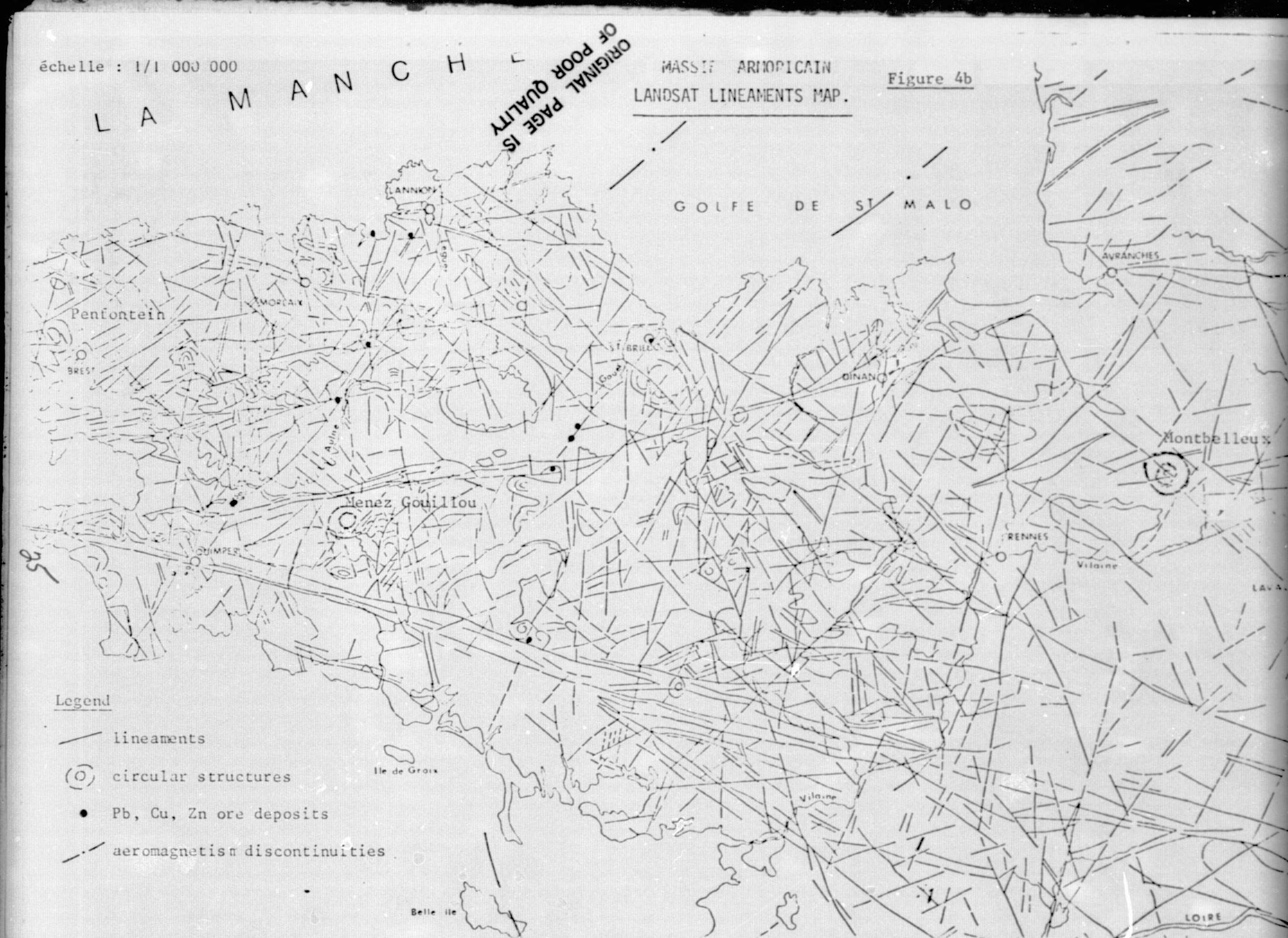
échelle : 1/1 000 000

L A M A N C H E

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MASSIF ARMORICAIN  
LANDSAT LINEAMENTS MAP.

Figure 4b



2.7. Program for next reporting period depends on the quality of further images, and the one received from the Lannion station are very cloudy until now, and on the possibility to obtain from NASA special products making possible a better interpretation, a temperature map for instance, when thermal inertia and temperature differences maps cannot be produced.

Other works to be performed concern aerial photographs, Landsat images, side looking radar, field mapping and geophysical data the gathering, interpretation and comparison contribute to the project.

### 3. CONCLUSION

Due to

- poor quality HCMM images (clouds cover) and
- lack of day and night thermal infra red data,

it is not possible to bring out a preliminary conclusion on the investigated topics. But differences appear over the uncloudy interpretable areas, related to lithology and tectonic, and this is encouraging.

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